Inter-comparison of Satellite Algal Bloom Detection Techniques Using Surface and Top of Atmosphere Signals

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ABSTRACT

- Use MERIS Satellite images of various coastal regions around the world to detect toxic algal blooms and inter-compare bloom detection techniques.
- Analyze bloom detection techniques with top and bottom of the Atmosphere signals
- Conclude which technique and top or bottom of the atmosphere signal provides the most accurate algal blooms detection.

INTRODUCTION

Algae, the most important plant on Earth

- The first plant on earth. Everything that produce biomass evolved from green algae (cyanobecteria)
- Produce more than 50% of global O2 while biomass is less than 1%. Half of the CO2 due to fossil fuel burning end up going to the ocean

Algal Bloom

A rapid increase in the number of microalgae

What is a Harmful Algal Bloom (HAB)?

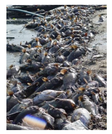
HAB is a bloom that produces toxins which are harmful to plants & animals.

- ~75% are dinoflagellate
- About 200 Hot Spot around the world

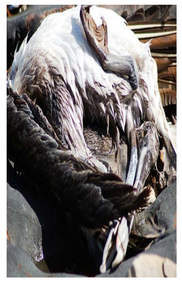
Reasons for Increase in HAB's

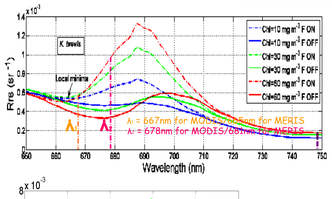
Production of food
Production of energy

Negative Impacts



- Kill marine life by oxygen depletion, light shading, gill irritation, and toxin production
- Cause millions of dollars in economic damages each year to fisheries and aquaculture facilities
- Decrease revenues for businesses in coastal areas due to water discoloration and beach closures
- Human intoxication through shellfish consumption or direct contact with the toxic species
- Toxins can also get into the air and cause harm to human such as skin and eye irritation





Algorithms:

Red Band Difference (RBD) (Ruhul Amin)

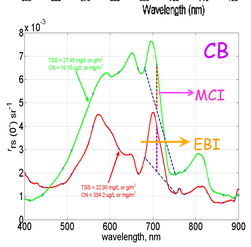
$$RBD = Rrs(681) - Rrs(665)$$

Extreme Bloom Index (EBI) (Ruhul Amin)

$$EBI = Rrs(709) - Rrs(665)$$

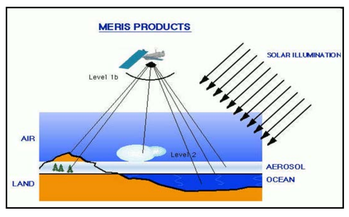
Maximum Chlorophyll Index (MCI) (Jim Gower)

$$MCI = L_{709} - L_{681} - (709 - 681) * (L_{753} - L_{681}) / (753 - 681)$$



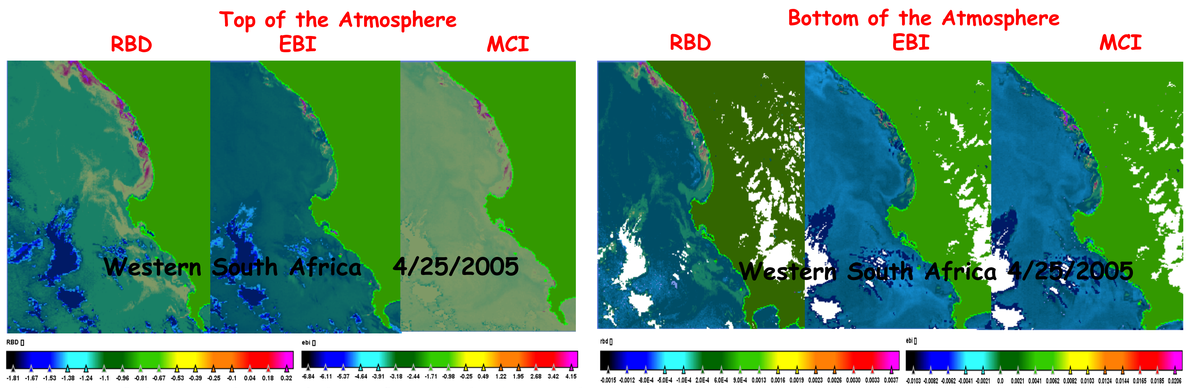
SATELLITE DATA

The MERIS was launched in March 2002 and has provided systematic global coverage at 1200 m resolution since June of that year. Satellite image data was obtained from ESA website [http://merci-srv.eo.esa.int/merci/welcome.do] for various dinoflagellates blooms hot spots around the world. BEAM 4.5.1 Software was used to create and analyze RBD,EBI, and MCI images for the selected studied regions.



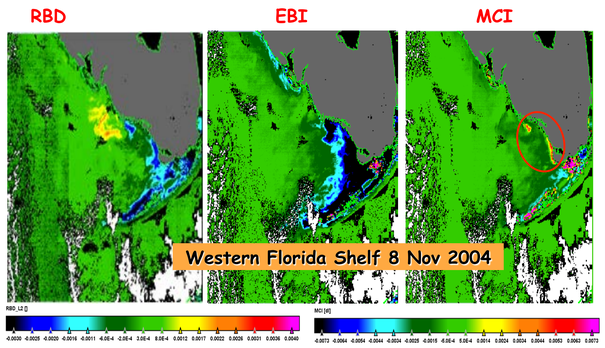
RESULTS

Comparison Between Top and Bottom Atmosphere Signals

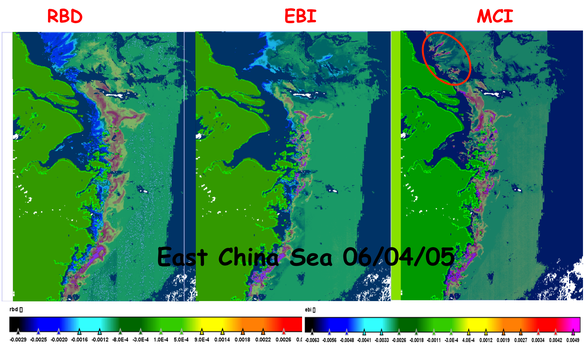


The top of the atmosphere and the surface signals gives nearly the same result. Images with both types of data can detect the true bloomed region. However, because of the atmospheric corrections' uncertainties, many pixels may be flagged out in the coastal waters for the surface data. So using top of the atmosphere signal might enable us to save some of those pixels.

Comparison Between Algal Bloom Detection Techniques Using Surface Signals

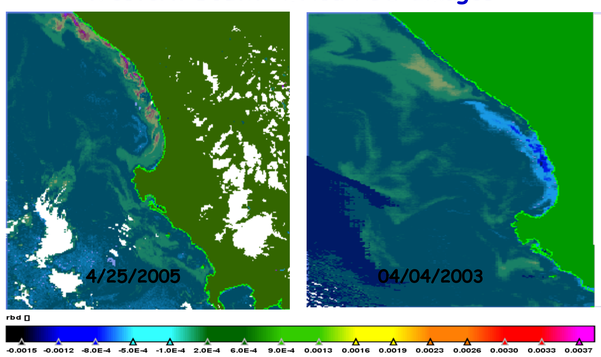


- In Western Florida, only RBD detects the true bloomed area whereas EBI and MCI don't detect it. MCI seems to give false readings.
- Example where RBD and EBI are different



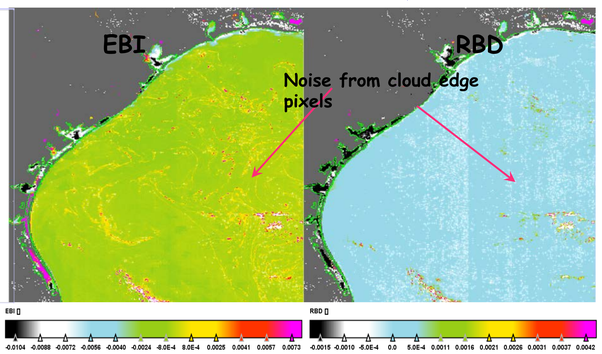
- Like Florida bloom, similar example can be seen in East China Sea where MCI seems to give false reading.
- RBD and EBI gives similar results for this bloom except that RBD also detects low those concentrations areas as well.

Western South Africa RBD Images



In Western South Africa, though in the same region, RBD can only detect algal blooms if they are dinoflagellate. In the second image, the bloom is not detected because it is a different species and reflects light differently.

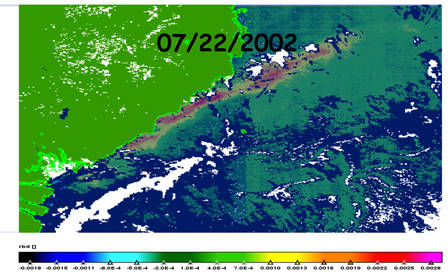
Gulf of Mexico June 2nd, 2005



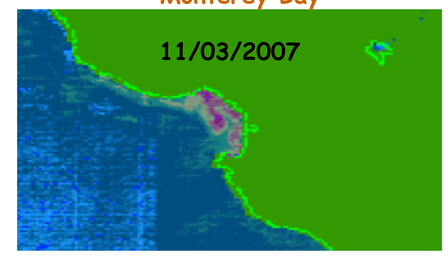
An example in the Gulf of Mexico where RBD does not detect the bloom because it is not dinoflagellate and EBI does detect it because the bloom concentration was high.

RBD Detects Toxic Dinoflagellates Blooms in Various Locations Around the World

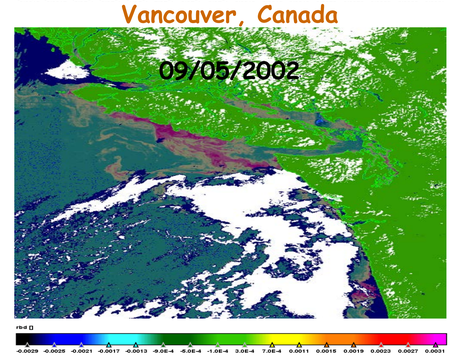
Vietnam, South China Sea



Monterey Bay



Vancouver, Canada



CONCLUSION

- Detection of algal blooms seems to be nearly the same with the top and bottom of the atmosphere.
- MCI seems to break down in highly turbid waters.
- RBD is found to be a very effective tool for dinoflagellates blooms detection whereas EBI only detect bloom with high chlorophyll concentrations

REFERENCES

- Amin, R., Zhou, J., Gilerson, A., B Gross, B., Moshary, F., Ahmed, S. (2009), "Novel Optical Techniques for Detecting and Classifying Toxic Dinoflagellate *Karenia brevis* Blooms Using Satellite Imagery," Optics Express Vol. 17, Iss. 11, pp. 9126-9144
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- Gower, J., S. King, G. Borstad, and L. Brown (2005), Detection of intense plankton blooms using the 709nm band of the MERIS imaging spectrometer, *Int. J. Remote Sens.*, 26, 2005-2012.

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